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# WMRC

## Waste Management & Research Center

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# Annual Report

# FY 2000

*George Ryan, Governor*

# Contents

We've changed the format of our Annual Report a little this year. We work very hard to plan for our future and pay close attention to where we've been. We also believe that everything that leaves the Center should make a lasting impression -- and our Annual Report should be no exception.

So, the WMRC Fiscal Year 2000 Annual Report is also a wall calendar for the year 2001. We take success seriously at the Center -- every day of the year.

This seemed like a good way to get that point across, and to better communicate our accomplishments and our future plans.


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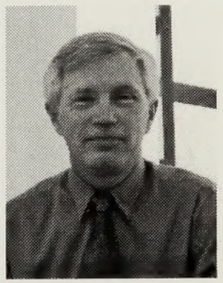
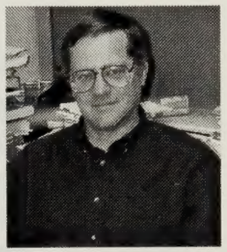
# "Welcome to a new way of looking at things."

**George Vander Velde**
**Director**



**Gary Miller**
**Assistant Director**



**John Marlin**
**Assistant to the Director**

Collaboration[1].

For many organizations it's the latest hot phrase. For the Waste Management and Research Center, it is quite simply a way of life.

At WMRC, collaborative effort is at the heart of every project we undertake as an organization. Our very nature, an organization crossing the spectrum from research to industrial support to information distribution, requires us to work in constant partnership. These same values are reflected in our interactions with our customers, our own agency and the other Illinois Scientific Surveys. These collaborations are a major component of WMRC's strategic approach to problem solving.

The problems of Illinois' environment and industry do not exist in a void. They are a part of a larger picture – one that crosses not only scientific and professional disciplines but also crosses geographic borders. The strength of the Center lies in our recognition of the big picture. Not only identifying problems, but also identifying all the sources of expertise essential to solving them.

WMRC's collaborative efforts bring a steady stream of federal and private funding to our agency and to the state. Last year, the Center received nearly one million dollars in support from these sources. These dollars translate into real, quantifiable improvements in environmental quality and economic success for Illinois.

With fewer than 60 full-time employees, we face great demands on our own resources. However, through our continued efforts to seek out partnerships and collaborative opportunities within Illinois, the country and even internationally, we have a powerful impact on our environment and our economy.

We have a vision and a plan to move forward, to grow and to expand our work. Whether to qualify for matching of federal dollars, or to create the capital and the intellectual infrastructure that make us uniquely suited to assist our partners, continued and increased support at the state level is essential to the success of the WMRC. This unique assistance, in turn, allows WMRC to sustain development within the State of Illinois.

The Center does make a difference. Every day. We've included just a few examples of some of our best efforts of the past year. We hope you'll take a few minutes to see just what the Waste Management and Research Center is all about.

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[1] **col•lab•o•rate** \k□-″la-b□-′ rℵt\ *vb* **-rat•ed; -rat•ing 1 :** to work jointly with others

# A Team Effort

WMRC staff as of July 1, 2000

**Administrative Services**
**George Vander Velde, Director**
**Gary Miller, Assistant Director**
**John Marlin, Assistant to the Director**

Judy Day
Katie Day
Tracie Klecz
Jeri Knaus
Tenna Knox
Cindy Melchi
Chris Murphy-Lucas
Cheryl Van Ness
Pam Splittstoesser
Randy Wahlfeldt

**Information Services**
**Bob Iverson, Manager**

Laura Barnes
Sandy Broda
Jini Cook
Chris Harris
Deb Jacobson
George Krumins
Todd Schumacher
Prill Smiley

**Natural Resources Trustee Program**
**Stephen K. Davis, Manager**

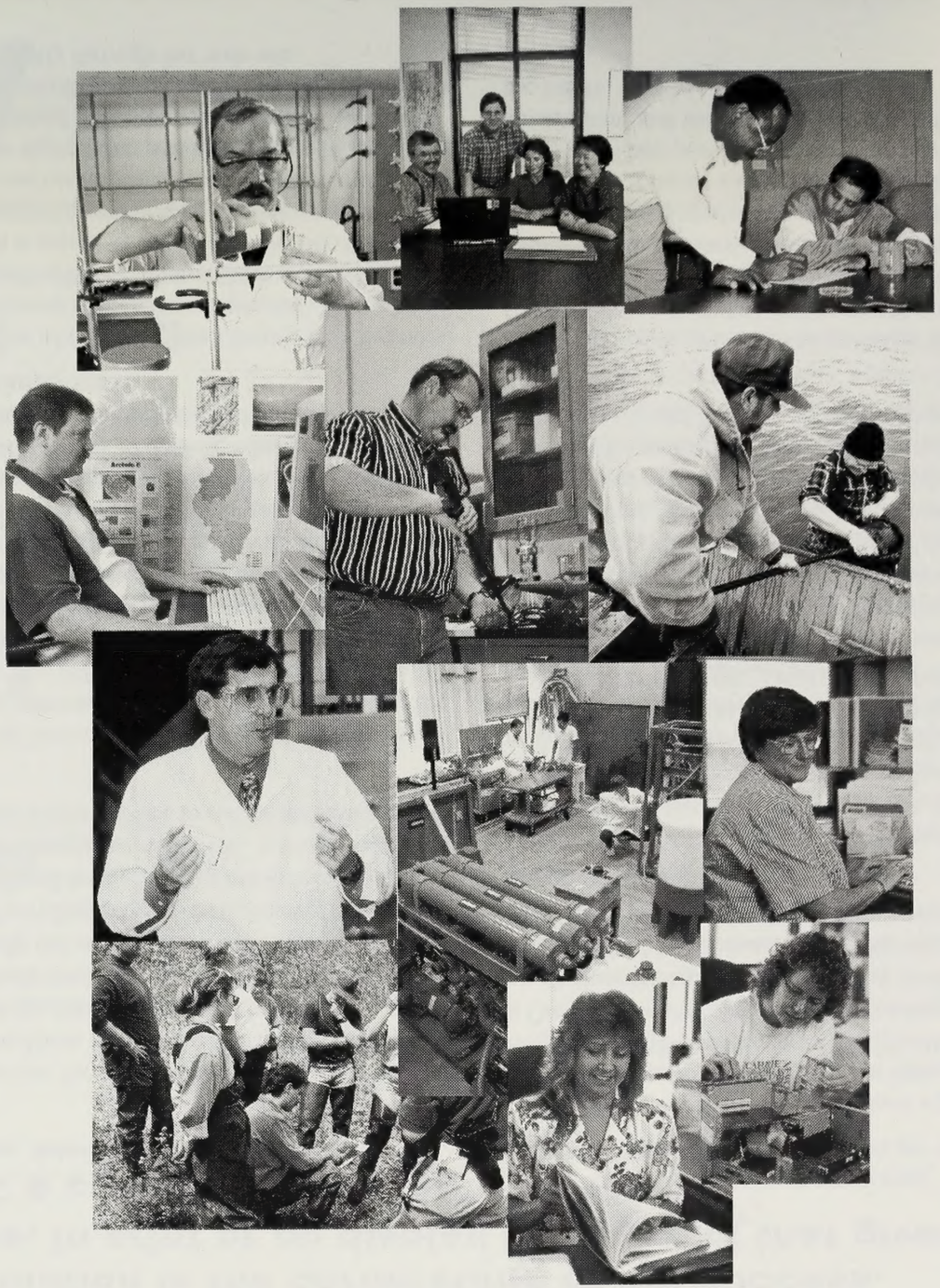
Ann Fletcher
Mike Henry
Denise Stoeckel

**Pollution Prevention Program**
**Tim Lindsey, Manager**

Ken Barnes
Malcolm Boyle
Jerry Brown
Georgene Frego
Chris Hayes
Cliff Jahp
Dan Kraybill
Bill Nelson
Joe Pickowitz
Kishore Rajagopalan
Ray Ronda
Todd Rusk
Mike Springman

**Research & Laboratory Services**
**Marv Piwoni, Manager**

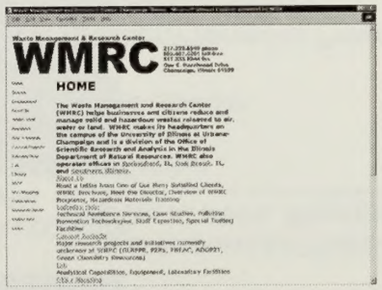
Gary Bordson
Teresa Chow
Brad Daniels
Julie Hafermann
Yakov Lazovsky
Dan McGinness
Chris Rohl
Jonathan Talbott
Luann Wiedenmann
Monte Wilcoxon



# Information Services

**"Information is the cornerstone of our success. On line, in print or on display it's the tool that gives WMRC a competitive edge."**

**Bob Iverson, Information Services Manager**



The Information Services Program (ISP) is focused on informing business, industry, government, and the public about the services provided by WMRC and about how both innovative technologies and common sense can help the environment and save money and resources. Providing services both internally, and on a state and national level, the information services staff allows better integration of WMRC's programs, which translates into better service to our customers and our partners.

Technological innovation has impacted no area more heavily than information and communication over the past decade. The ISP, faced with constant shifts in customer demands, heavier usage and a playing field that constantly reinvents itself, has made fundamental changes in our staff structure and in our approach to information management. This provides more dynamic, more effective and more targeted customer service. Things change quickly in our field, and the only successful means of dealing with this is a group-wide commitment to anticipate and plan for the future rather than simply react.

A core element of the ISP is the Library, which specializes in the science of waste management. With over 5000 reference volumes, 200 periodical and thousands of maps, it is a unique institution in the US. Our staff of professional librarians ensures quick access and fast response to current issues . A major initiative in FY 2000 was the digitization and distribution of the WMRC-published Research Collection. Fifteen years of Illinois-centered research funded by WMRC is now available instantly through our web site.

The WMRC web site was the other area of concentration for the ISP over the past year. The ISP coordinated a Center-wide task force that worked together to create an electronic framework that allows for faster distribution of valuable information and that opens the way for expansion and modification for future needs and opportunities.

ISP also houses the Geographic Information Systems (GIS) which uses computers to create, analyze, and display temporal, spatial and visual data on geographic templates. While the power of GIS computing has increased dramatically over the past, it has remained a tool reserved for high-end power users with a great deal of specialized knowledge. However, the new ecView software created for the Department of Natural Resources now allows for advanced manipulation of large sets of data and the generation of detailed maps. It reports in a "point-and-click" interface easily used by any level of computer user. While ecView is not yet available for public distribution, it promises to be a valuable GIS tool that can be used by just about anyone.

Other vital parts of the ISP Department are the Great Lake Regional Pollution Prevention Roundtable, the Pollution Prevention Resource Exchange, and the Printers National Environmental Assistance Center. These programs speed information dissemination and technology transfer for successful pollution prevention practices. They provide important arenas where government and industry can come together to shape the future.

# January
## 2001

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | 1<br>New Year's Day | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 14 | 15<br>Martin Luther King Jr.'s Birthday | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| 28 | 29 | 30 | 31 | | | |
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## Governor's P2 Awards

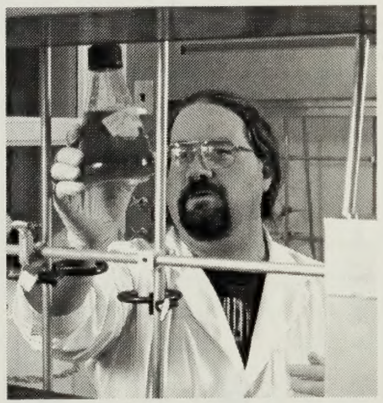
Since 1986, WMRC has sponsored and coordinated the Illinois Governor's Pollution Prevention Awards. This annual recognition program honors industrial facilities, vendors, trade organizations, community groups and educational, government and service organizations for their outstanding efforts in reducing or eliminating pollution. Our winners are seen as companies that combine solid business practices with environmental concerns to create better products in better ways. There are more than 100 past winners, ranging in size from 5 to 5000 employees.

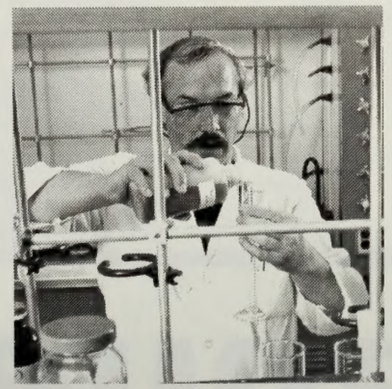
**Since its inception, Governor's Award winning companies have reported average annual waste reductions of nearly 2 million tons, and a cost savings of $27 million.** Pollution prevention definitely pays. These successes are direct contributors to Illinois' position as a national industrial and environmental leader.

These organizations have made a commitment to include pollution prevention and waste-minimization as part of their operations. It is seen not as a cost of doing business, but as a better way of doing business. They are leaders and innovators in their fields, and it is WMRC's annual pleasure to congratulate them for their impressive achievements.

Information about deadlines and the application procedure is available on the WMRC web site at www.wmrc.uiuc.edu.

# Laboratory Services





## "Technology is important, but that's not the heart of good analysis. It's our expertise, our people, that brings researchers from all arenas into our labs."

**--Marv Piwoni, Laboratory Manager**

WMRC's analytical laboratory is a research support facility providing solutions to analytical problems posed by scientists within the Center, the Department of Natural Resources, the University of Illinois at Urbana-Champaign and other Illinois institutions and businesses. The laboratory supports the analytical needs of the Center's Pollution Prevention Program, assists the Natural Resources Trustees Program, and often provides analytical services to researchers receiving funding through the Center. These collaborations, partnerships and services result in a better understanding of Illinois' environmental problems, while bringing significant funding from federal and private sources to Illinois.

The laboratory offers analytical capabilities for most regulated environmental contaminants and for a variety of industrial process constituents. Laboratory staff have developed expertise in speciality analysis of metals at low levels and in small volumes, of explosive compounds and their degradation products, of pesticides and PCBs, and of a variety of surfactants and industrial cleaner constituents.

Attracting and retaining the best staff has been and remains a program priority. This year, the lab recruited two chemists to fill vacancies in the Gas Chromatography Group. The senior chemist came to us in December with a Ph.D. from Indiana University's environmental chemistry group. A support chemist, an MS graduate from the University of Illinois, joined the staff in May. The additions brought the laboratory staff to eight chemists, two support staff and the Program Manager.

While staff excellence is the driving factor in the lab's success, top level analysis requires top level technology. The laboratory added some important new analytical instruments this year. In the metals group, a new inductively coupled plasma - mass spectrometer (ICPMS) greatly increased the laboratory capabilities to measure low concentrations of over 80 elements. Replacement ion chromatograph and purge and trap equipment were added in the GC/MS group. The laboratory also acquired an Accelerated Solvent Extraction unit for extracting organic constituents from solid (soil, sediment, tissue) samples. These investments will enable WMRC analysts to offer our customers more accurate and faster services.

The laboratory worked on several major projects over the year. Ecotoxicological studies being conducted by the Illinois Natural History Survey at the IDNR's DePue Wildlife Management Area yielded numerous organ samples from rodents and raccoons. The lab performed metals analysis on these and numerous soil samples for the contamination site.

The laboratory provided analytical support to two projects funded by the Center. Volatile and semivolatile organic compound screening data were provided to a study on the waste waters associated with wet cleaning techniques proposed to replace solvent-intensive dry cleaning. Target pesticide analysis was performed to support a study of agricultural pesticide migration from the field where the chemicals are applied to the Embarrass River watershed.

# February
## 2001

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | | | | 1 | 2<br>Groundhog Day | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12<br>Lincoln's Birthday | 13 | 14<br>Valentine's Day | 15 | 16<br>Governor's Awards Applications Mailed | 17 |
| 18 | 19<br>President's Day | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | | | |
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## North American Amphibian Project

The frogs are disappearing. And those that aren't disappearing are manifesting high rates of deformities and other indications of poor health. That's the story in Minnesota, Panama, and throughout much of the world

Researchers have begun looking into the alarming loss of these amphibian populations. WMRC's analytical laboratory is playing a major role in this search as part of a broad research team that includes specialists from universities and the federal government. The WMRC lab is conducting the chemical analyses that will help determine if environmental contamination is playing a role in the amphibian population decline.

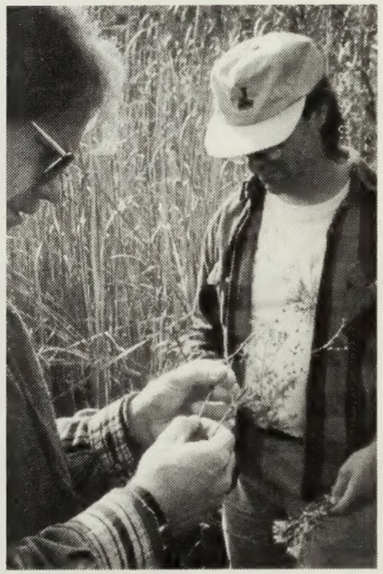
When looking for needles in biological haystacks, accuracy of measurement and the quality of analysis are absolutely essential. Looking for chemical contaminants in pond waters, sediments and tissue samples requires a variety of steps from sample collection through delivery of data to the research team. WMRC staff bring the expertise necessary to meet this challenge.

WMRC's "Frog-lab" experiences will continue to add to our ability to provide chemical analysis of tissue and other environmental samples to support future ecotoxicological research efforts.

# Natural Resources Trustee Program

## "We work with Illinois companies to find ways to restore the environment. We measure success by damage repaired and ecosystems restored."

**Stephen K. Davis, NRTP Manager**



The Natural Resource Trustee Program (NRTP) continues to remediate and restore Department of Natural Resources (DNR) lands and assess injury to natural resources within Illinois. The addition of three full time staff, and a graduate intern during the past year, helped NRTP to be more effective and efficient in its efforts toward developing DNR's role as a natural resource trustee. The ongoing caseload for the NRTP now includes over 70 projects, up significantly from last year's 21. The NRTP has developed an internal Department-wide network for the identification of natural resource injuries in Illinois and drafted a Department Policy & Procedure that defines how to report and document a potential natural resource injury for DNR staff. The NRTP has also been connected to the National Response Center "Flash Fax" service which provides immediate notification of oil or hazardous substances releases within the State of Illinois. This process alone has given notification of nearly 1,100 spill events since March of this year, which have been reviewed and evaluated by the NRTP.

The NRTP has focused this past year on obtaining specialized staff training in the areas of wetland delineation, natural resource damage assessments, Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and a number of other areas essential to our mission. Based on this training, staff from the NRTP have become actively involved in projects such as the Joliet Army Ammunition Plant (Midewin National Tall Grass Prairie), Savanna Army Depot, Texaco Lawrenceville, and Lake Calumet to name a few.

The NRTP has also been successful in working with various companies to determine the degree of injury to natural resources caused from oil or hazardous substance releases. These efforts have been in the form of "cooperative assessments," where the potentially responsible party (PRP) requests NRTP involvement to assess the degree of natural resource injury in an effort to resolve a portion of their environmental liability as a result of the release.

With the ever-increasing awareness by DNR employees of environmental contaminants, the NRTP was also notified of several Department-owned properties that were in need of remediation and/or characterization. The NRTP also participated in a number of Phase 1 environmental audits and the review of various prospective property purchases by the Department.

The NRTP will once again initiate the Midwest Natural Resource Trustee Regional Roundtable in late winter/early spring. The inaugural roundtable, held in late 1998, was such a success that we feel it to be an essential tool in the continuing development of the natural resource trustee process nationally. The NRTP will put a greater focus on outreach and providing information on natural resource damage issues to those in the industrial and environmental communities. The NRTP outreach efforts will also include working closer with USEPA Region 5 and the Illinois EPA in the early integration of trustee matters into response and remedial actions.

Additionally, NRTP must continue to provide support to all Department programs when environmental contaminants are of concern. Areas such as property acquisitions, open dumping, and historical contamination will continue to be a key duty of the NRTP.

# March
2001

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | | | | 1<br>Casimir Pulaski Day | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17<br>St. Patrick's Day |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |
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## Millhurst Fen Restoration

Historically, environmental compliance and protection has been based largely on punitive fines assessed against legally responsible parties. The NRTP group approaches the issue from a new direction. We place the priority on cooperative restoration or replacement of the damaged resource rather than on punishing the responsible party.

The first test of this model came in 1998, with the Millhurst Fen in north-central Illinois. Fens are a special class of wetland that exist in harsh environments and rely on underground water for sustenance. A spill from an underground pipeline-drilling operation poured waves of bentonite clay over the ecologically-sensitive fen. This type of clay is used to form non-transmissive walls on pipeline tunnels. The long-term danger from the spill was that the clay would significantly alter the groundwater hydraulics, and effectively, smother the site.

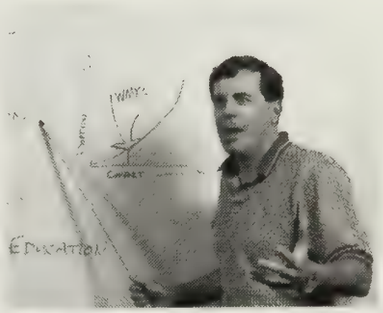
Fining the mining company would have done nothing to preserve, repair or save the fen. Instead, WMRC, DNR and the drilling company created a plan that put the Millhurst Fen first. Quick action was taken to remove the spilled clay and to allow the natural water flow to continue on the native soils. The final agreement included money to manage invasive/exotic species and to develop a public education program based on the Millhurst Fen. The fen was purchased by the company and donated to the State of Illinois for future management and monitoring as an Illinois Dedicated Nature Preserve.

The end result of this process is the full restoration and preservation of a scarce wetland: WMRC's model for the future of environmental resource protection.

# P2 Program

## "Implementation. That's what we consider success. It's not a solution if our customer doesn't use it."

**Tim Lindsey, Pollution Prevention Program Manager**



In FY 2000, the Pollution Prevention (P2) program continued its efforts to provide industrial technical assistance, diffuse promising P2 innovations, and perform research to develop new P2 technologies. This approach to promoting P2 is unique among the national community of assistance providers and efforts are underway in several surrounding states to copy many of our program's elements. WMRC is working closely with representatives from Wisconsin, Minnesota, Iowa, Indiana, Kentucky, Pennsylvania, Georgia, and Massachusetts to help them incorporate WMRC methods into their P2 assistance programs.

Our P2 staff provided on-site technical assistance, including site assessments and recommendations for process improvement, to Illinois companies on 192 occasions. P2 diffusion efforts continued with the Accelerated Diffusion of Pollution Prevention Technologies (ADOP$^2$T) initiative for the metal finishing industry in the Chicago area. WMRC engineers completed technology diffusion projects involving membrane filtration, conductivity controls, diffusion dialysis, energy efficiency, and initiated several other projects to evaluate alternative barrel designs, cyanide recovery and recycling and cyanide substitution. In addition to the ADOP$^2$T projects, WMRC engineers conducted 11 other pilot projects in a variety of industrial sectors.

In addition to the metal finishing ADOP$^2$T initiative, WMRC engineers began an initiative in the metal forming and machining sectors. WMRC is collaborating with some of the most progressive suppliers of industrial chemicals to this sector in an effort to encourage them to adopt innovative P2 technologies and supply them to their customers on a service basis. A prioritized list of technologies and research priorities has been established with this group and pilot evaluations of some technologies will commence in FY01.

WMRC research engineers have continued their efforts in developing methods to recycle machining coolants, optimize coating systems, and recycle cleaning solutions. Examples of the projects undertaken include:

- Evaluation of a membrane filtration processes for recycling machining coolant with Caterpillar corporation and a UAW-Chrysler/Daimler consortium.
- A project was executed that evaluated methods for optimizing powder coating processes (See below).
- Environmentally safe processes for cleaning M-16 rifles were developed for the Department of Military Affairs. In FY2001, WMRC will build and test a prototype system for use in the field.
- A microbial process for removing oil contaminants from industrial degreasing operations was successfully evaluated.
- A prototype of a self-recycling industrial parts washer was developed and successfully tested in the field.

Over the next several years, the P2 program plans to build on its status as a premiere P2 assistance program by creating awareness of innovative practices, developing sound technical principles for improving process efficiency, and assisting with the implementation of the practices that are recommended by the staff.

# April 2001

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| 1<br>Daylight Savings Begins | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 |
| 22<br>Earth Day | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | | | | | |
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## R.B. White Powder Coating Study

Powder coating has emerged as an alternative to conventional coating methods in many applications due in part to its superior environmental performance, especially in reducing volatile organic emissions and solid waste.

Success in powder coating requires not only the realization of consistent, quality coatings, but also the ability to apply these coatings efficiently. Higher efficiencies result in lower material costs.

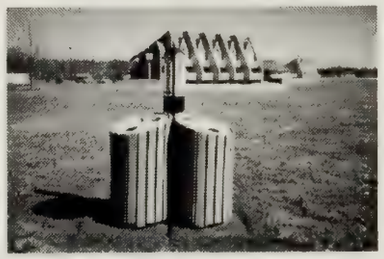
One Illinois facility, R.B. White, consumes powder at a rate of about 102,000 pounds/year, while generating scrap powder at a rate of about 15,300 pounds/year -- a utilization efficiency of 85%. If the utilization efficiency could be increased to 95%, the company would prevent 10,700 pounds of solid waste and save $32,000 annually, assuming that powder costs $3/pound. This translates into annual savings of $3,200 for every 1% increase in utilization efficiency.

This study, conducted at R.B. White's Bloomington, Illinois facility, examined the impacts of parts racking arrangement, gun-to-parts distance, powder feed rate, and applied voltage on first pass transfer efficiency (FTPE) as a means of improving and controlling the powder coating process.

According to WMRC's findings, FPTE will be high when parts are racked closely, but not overlapping; powder feed rate is low; gun-to-parts distance is about 10"; and applied voltage is high, at least 80 kV.

This research project is part of the groundwork for WMRC's plans to begin applying the ADOP$^2$T model to coating and painting applications this year.

# Recycling Program



**"Recycling needs to be automatic. It saves landfill space and conserves our natural resources. By closing the loop by purchasing recycled content products, we enable the markets to flow more evenly."**

**Jeri Knaus, Recycling Coordinator**

The Waste Management and Research Center is committed to eliminating waste as much as possible in its operations and recycling the remaining material. In May, 2000, WMRC added the Recycling Coordinator position, formerly managed directly by the Department of Natural Resources (DNR). This position plans, develops, evaluates and executes the statewide Department recycling program in offices as well as state parks, fish and wildlife areas and forestry locations.

Since 1995 this position has brought approximately $127,000 to the recycling program through outside grants. In addition, those grants were matched through DNR in-kind and monetary contributions of over $131,000. These dollars were used to fund the expansion of recycling at five state parks, one state park lodge and offices housing DNR employees in Springfield and regional locations. In addition, funds were used to purchase outdoor furniture at Eldon Hazlet State Park. In an effort to "Close the Loop" in the recycling industry, all collection units purchased were made from over 25% recycled content, (generally 50% - 100% recycled content). The furniture was made from 50% wood fiber and 50% recycled plastic. Upon transferring the position to WMRC, writing bid specifications and purchasing the recycled content outdoor furniture and recycling receptacles for one of the five parks has been completed. All products have been delivered and are in use.

Another area of concern for DNR was the obsolete paint and chemicals that the state parks had on hand. It was apparent that these items could not be land filled, so the Recycling Coordinator took inventory from all the state parks and found that out of over 260 sites, only 34 locations had items that needed to be hauled away by a licensed hazardous waste hauler. A "Request for Bid" was placed on the internet and a hauler was selected. This project started in June 2000 and will run 36 months, spanning four fiscal years, to allow sites to budget for the removal. To date, work at 19 sites has been completed. Items removed from the sites included obsolete paint, pesticides, herbicides, creosote, contaminated used motor oil, antifreeze and various other hazardous wastes.

As a result of the hazardous waste cleanup project, the Recycling Coordinator is co-chairing the Waste Management Strategies Committee for DNR. The purpose of this committee is to establish policy for DNR staff in the handling of used motor oil and other wastes that may not be land filled.

With the transfer to WMRC, one of the first activities was to conduct a waste assessment of the Center's Champaign facility. The results led to creation of a Center team to set goals for future waste reduction and for continued measurement of our progress in the area.

While WMRC's primary mission is to eliminate and prevent waste from being created, we recognize the practical realities of this. Recycling has been, and will continue to play a major role in nearly all waste management practices. The addition of this position to our staff will give us yet another source of expertise and another tool in our commitment to providing the best environmental solutions to Illinois.

# May
## 2001

| Sunday | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13<br>Mother's Day | 14 | 15 | 16 | 17 | 18<br>Governor's P2 Applications Due (Tentative) | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28<br>Memorial Day | 29 | 30 | 31 | | |
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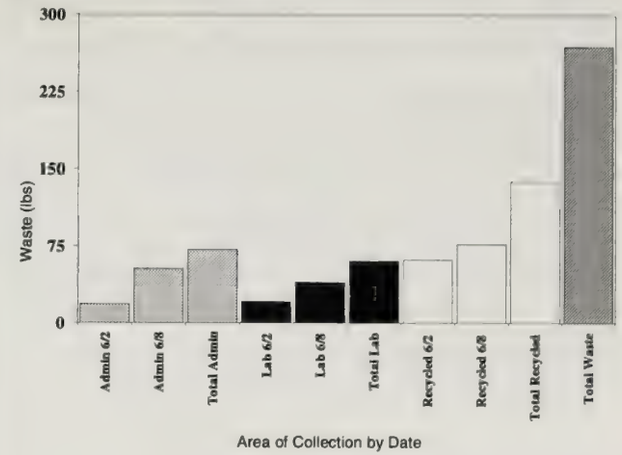
## WMRC Waste Audit




On June 2nd and 8th unannounced assessments were undertaken of waste generated in our Champaign office. These assessments covered a weeks worth of waste. The chart above summarizes the results. On the positive side, about 51% of the total waste (by weight) was recycled. About 89% of recyclable paper was recycled.

Areas of concern include:

- 15.2 pounds (almost 12%) of garbage was recyclable office paper
- Reusable items were found in the trash including plastic eating utensils, beverage containers, and certain other plastics
- Since WMRC is located on the U of I campus we take advantage of the University's trash and recycling program. While many recyclables are hand sorted from trash, it is preferrable to separate as many recyclables as possible at the source.

As a result of this assessment a Pollution Prevention and Recycling Policy was adopted to set waste reduction goals and to establish methods of tracking our progress.

# Research Program

**"Our funded research creates new relationships, new networks and new partners for the Center. With them, we act faster, anticipate trends and bring better solutions to Illinois."**

**Julie Hafermann, Research Project Coordinator**

One of the Center's most dynamic resources is our Research Program. Our sponsored research projects give us the opportunity to enlist substantial sources of expertise and knowledge beyond WMRC in our efforts to identify, characterize and mitigate waste-related problems in Illinois. Our research grants are quite literally an investment fund for the state's environmental future. This program has been a part of WMRC since our founding and remains a keystone in our strategic positioning efforts.

The appropriated research program budget for this year was $595,300, with $195,300 of that budgeted from WMRC's General Revenue Fund. An additional $68,800 was made available by IDNR to support projects focused on contamination in the Donnelly-DePue Wildlife Management Area. About $504,000 was spent on projects that were initiated in FY00, with additional monies being committed to support continuing projects.

The research staff is responsible for soliciting proposals from the research community, thoroughly reviewing them, selecting proposals for funding, and managing funded projects through to completion. A total of twenty-six proposals were submitted in response to the spring, 1999 solicitation. Seventeen of the proposals were chosen for external review. A minimum of two reviewers with expertise in the proposal subject area were solicited for each proposal. Proposals were specifically evaluated for appropriateness to the solicitation topics/and or interests of the state; knowledge of pertinent literature; clearly defined problem and experimental approach; qualifications of the researchers; and feasibility to complete the project in proposed time-frame and budget. Six of these proposals were selected for funding.

Three additional research projects were funded later in the fiscal year. These proposals were solicited directly, due to WMRC staff involvement with researchers working in areas of particular interest to the Center.

WMRC Research Program staff work with the researchers, providing feedback on quarterly progress reports and addressing any administrative problems that arise. Project final reports are subjected to peer and editorial review prior to publication. Results of these funded projects are disseminated by several routes. Sponsored projects may appear in journal articles and technical publications, at meetings and seminars, and in fact sheets and brochures. Most WMRC-sponsored project final reports are published by WMRC and are available through our Library and Clearinghouse.

The research solicitation for projects to be funded in FY01 was developed and mailed to prospective researchers in late winter. The focal topic areas in this solicitation were:

**Technologies for Pollution Prevention**

**Pollution Prevention and Sustainable Development**

**Industrial Process and Environmental Monitoring Test Methods**

Twenty-five proposals were received and reviewed.

WMRC's research staff will seek to improve the quality of its solicitation mailing list to get the solicitation into the hands of more people who are likely to respond with a proposal. Staff will also seek to improve project management by increasing contact with funded researchers with goals of improving timeliness of project deliverables and reducing last-minute project extensions. And in the context of future solicitations, the research staff will begin developing a research strategy that will identify priorities within a longer term funding plan.

# June
2001

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## New Research Funded in FY 2000

### Ecological Risk Assessment:

Jocelyn Aycrigg, Jeff Levengood, UIUC, "Applying Spatial Information Technology to Ecological Risk Assessment in Illinois." 15 months. $49,917 (co-funded with IDNR-OREP).

Sabine Loew, ISU, "Mutagenicity and Fitness Impacts in Wild White-Footed Mice Due to Exposure to Environmental Pollutants." Six months. $15,400.

Richard Halbrook, SIU, "Assessment of Risk of Mink Exposed to PCB's in the Lower Illinois River Watershed." Six months. $13,200.

Mariangela Segre, UIUC, "Validation of a Potential Biomonitor for Contaminated Sites. Effect of Persistent Organic Pollutant (POP) Exposure on Fetal Development." Six months. $16,500.

Grant Bunker, IIT, "In situ Speciation of Mercury in Fish and Marine Mammals by X-Ray Absorption Sprectroscopy: A Preliminary Study." 6 months. $26,925.

### Industrial Pollution Prevention:

Chicago Metal Finishers Institute, "Implementation of ADOP$^2$T Technical Assistance Methods for Chicago' Metal Finishing Industry." 10.5 months. $50,000.

Munir Cheryan, UIUC, "Reuse of Electroplating Wastewater. An Investigation into Factors Affecting Reliability of Reverse Osmosis." 27 months. $86,597.

### Contaminated Levels in Soil:

Michael Machesky and Thomas Holm, SWS, "Speciation and Potential Toxicity of Metals and Ammonia in Peoria Lake Sediments and Pore Waters." 14 months. $57,615.

Michelle Wander and Ted Peck, UIUC, "Historic Soil Samples - building a database." 6 months. $7,700.

# Illinois River Restoration Project

Marshal County State Fish & Wildlife Area

Cable Arm (TM) clamshell bucket

Eddy Pump (TM) dredge discharge

Buried object detection test

## "Sediment is filling our water supply reservoirs and destroying aquatic habitat worldwide. If we succeed at efficiently removing and using Illinois River sediments, the technique should be adaptable to many other regions"

**John Marlin, Assistant to the Director, WMRC**

The Illinois River and its backwaters have accumulated vast quantities of sediment over the past 100 years. Thousands of acres that once supported fish waterfowl and recreational activities are now less than 18 inches deep such as this backwater (at left) in the Marshal County State Fish and Wildlife Area near Chillicothe. Illinois is planning an ecological restoration project, known as Illinois Rivers 2020, that will focus on floodplain and hydrologic functions, land treatment to control erosion, and remove sediment from selected areas.

WMRC's John Marlin is coordinating DNR efforts in several areas, particularly dredge technology and sediment placement and beneficial use. Numerous other agencies and companies from around the country are participating in the project. Likely uses of sediment include island building, landscaping soil, soil supplement and cover or fill on brownfields and stripmines. The various uses depend on the physical and chemical properties as well as transportation and handling considerations. For efficient movement by truck, rail, or barge, the sediment should be as dry as possible to minimize weight. High solids hydraulic techniques can increase the efficiency of handling sediment by pipeline.

The Eddy Pump(TM) high solids dredge and Cable Arm(TM) clamshell bucket designed for soft sediments were both demonstrated on marina access channel projects during 2000. The clamshell removed sediment directly from the river bottom without adding water. This allowed it to dry relatively quickly. Sediment from the river was hauled by truck and spread on a future East Peoria park at an old industrial site in May. By early July it had dried and was pulverized and disked. By September it was covered with vegetation.

DNR and a University of Illinois soils specialist evaluated sediment dredged from the river and downstate reservoirs in the past. Fields with sediment-derived soils had physical attributes comparable to high quality soils. In greenhouse tests Peoria Lake sediment performed as well as Champaign County topsoil in germination and growth tests. The sediment is being subjected to a battery of tests to determine if it contains contaminants that would limit its use as soil.

WMRC also organized the testing of ground penetrating radar, sonar, a magnetometer and other equipment to evaluate the possibility of detecting objects buried in sediment. This included designing and building a towed platform for carrying instruments above and below the water surface. Another project is examining the potential commercial value of sand and gravel deposited by river tributaries.

If high volume sediment removal proves feasible, the techniques could also be used to restore the capacity of municipal water supply reservoirs.

# July
## 2001

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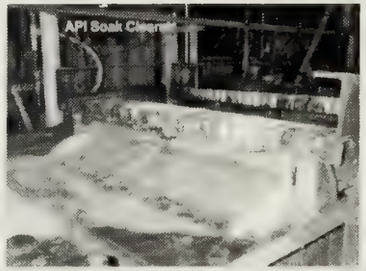
### Sediment for Topsoil for an East Peoria Park

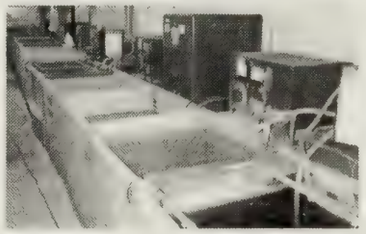
Placed in May, 2000

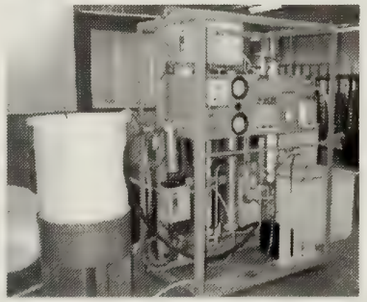
Dried and disked in July, 2000

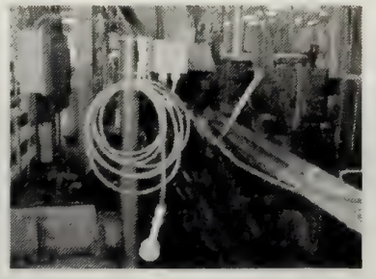
Covered by vegetation in Sept., 2000

# The ADOP²T Program







## "Programs like ADOP²T are going to be helpful for small business people like me so we can sit down and see how these technologies can work in our shop."

**Dave Jacobs, President, Northwestern Plating and 1999 ADOP²T Participant**

The Waste Management and Research Center (WMRC) has developed a customer-driven technical assistance program to improve adoption of pollution prevention technologies in industry. The ADOP²T (short for Accelerated Diffusion of Pollution Prevention Technologies) program is a process of identifying best practices, executing brief demonstrations and extended pilot trials of pollution prevention (P2) practices and technologies in actual facilities. We ask the industry to define their needs, their problems and what technologies or practices they would like to see explored. Pilot trials provide the site-specific information required to influence company decision-makers to adopt these technologies where economically and technically feasible.

WMRC has long understood that simply telling someone about a new technology is unlikely to result in implementation of it. The primary goal of the ADOP²T program is to shorten the time it takes to get the very best practices and technologies for an industry into widespread use. The biggest obstacle to innovation is uncertainty. Innovation has definite risks. "Will it work in my operation?" and "Can I afford to take the chance that it won't?" are the basic questions that the ADOP²T model was created to address. We must get past these questions before we can help our customers.

By working with companies, with their staff, in their plant, on their lines, WMRC answers the questions, overcomes the obstacles and removes the uncertainty. We don't just talk about technologies in ADOP²T, we show how they work. We're partners with the ADOP²T participants. We invest our time and our resources right alongside with the company. If you want to reduce uncertainty, you have to be willing to put yourself on the line, literally and figuratively. We share the risks, we share the work, we get results.

The key to the success of the ADOP²T model is recruiting an industry's opinion leaders as participants. Companies generally do not look to us, as government, as experts and trusted sources of technical information. Rather, they look to their peers, their competitors, and their vendors for this information. And, not surprisingly, they give more weight to the opinions and practices of the best of those. These are the targets for ADOP²T. Convince the opinion leaders to implement a practice or a technology and it's a good bet a number of others in the same industry will be close behind. This is how innovation becomes standard practice. This is how ADOP²T is changing the way people think nationwide about technical assistance.

With a model in hand, WMRC chose to field test it with the metal finishing industry. Metal finishers were seen as a promising area for several reasons: We already had a great deal of technical expertise in the field; metal finishers have been under increasing regulatory pressure in recent years; and, generally, it is an industrial sector with companies that want to improve their operations, but often simply lack the technical resources to explore innovative practices.

The Chicago Metal Finishers Institute (CMFI) and Scientific Control Laboratory, Inc. are working in cooperation with WMRC to conduct over thirty individual projects at eleven volunteer metal finishing shops in the Chicago area. Project engineers are developing and executing projects including demonstrations and pilot trials of innovative pollution prevention processes and technologies at these "mentor" sites. Results of these efforts are being used to promote the adoption of the technologies and practices at other metal finishers in the region.

# August
2001

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## Conductivity Controls at Craftsman Plating

Product quality in metal plating operations is dependent on how well contaminants are rinsed from the work pieces. A common practice is to continuously run fresh water into the rinse tanks to maintain high rinse water quality. However, this leads to excessive water consumption, and increased production and waste treatment costs.

Craftsman Plating, in Chicago, was having just this problem. WMRC suggested adding conductivity controls to meter their freshwater additions. Rinse water quality can be correlated to the conductivity level in the rinse tanks. As conductivity rises, contaminant levels are climbing and water quality is dropping. Using a control system that monitors this and controls the valves, water can be added only when needed, and in optimum quantities.

WMRC worked with Craftsman to test these controls on two of its rinse tanks. Craftsman estimates that, using these units on this line alone, it will reduce water usage by 55,900 gallons a year. Factoring in water cost and treatment expenses, Craftsman expects a direct payback on the conductivity controls of about one year. However, other benefits, such as the potential for increased internal production rates, have made the plant-wide installation of these controls a Craftsman priority.

As participants in the ADOP$^2$T program, Craftsman will serve as a mentor/demonstration facility for conductivity controls in the Chicago area. The results of this project will continue to benefit Craftsman and the Illinois environment.

# Greater Chicago P2 Alliance

**"The Greater Chicago Alliance builds trust that comes from close collaboration. We know we can rely on each other. And, our customers know they can count on us."**

**Chris Hayes, WMRC Greater Chicago P2 Alliance Engineer**

In 1992, federal, state and local environmental agencies in the Chicago began to meet regularly to share information on their pollution prevention (P2) activities and investigate opportunities to pool resources and work collaboratively. Shortly thereafter, the agencies were joined by community development groups, environmental organizations and businesses interested in linking P2 to local economic development and environmental improvement initiatives. WMRC, while located in Champaign, recognized that the Chicago area was a major market for our services and that this initiative would offer excellent inroads to the area.

WMRC's primary focus as a participant has been to provide direct technical assistance to implement waste management and pollution prevention technologies and practices. This aspect of the project has been funded by USEPA since 1994. In addition, the Metropolitan Water Reclamation District has been providing an office and related support to house the WMRC process engineer in downtown Chicago. During the past grant period, there have been 84 on-site visits to provide technical assistance to Chicago area companies. 23 of these visits were from direct referrals from Alliance members. Technical assistance focuses on pollution prevention assessments and technology evaluation but sometimes also includes compliance assistance.

The members of the Greater Chicago P2 Alliance currently include the following agencies, businesses and organizations

- Argonne National Lab
- Citizens for a Better Environment
- City of Chicago Department of Environment
- Chicago Legal Clinic
- Cook County Department of Environment
- Gardner, Carton and Douglas
- Illinois Environmental Protection Agency
- Illinois Waste Management and Research Center
- Illinois Department of Commerce and Community Affairs
- Metropolitan Water Reclamation District of Greater Chicago
- North Business and Industrial Council
- S & C Electric
- U.S. Environmental Protection Agency

Working cooperatively within this alliance has been so successful that it has fostered other collaborative efforts between WMRC and other agencies throughout the state. Ultimately, this is the power of networking as we see it. Success speaks for itself, and becomes a self-sustaining event. Projects like the Greater Chicago P2 Alliance are outstanding examples of how we leverage scarce resources into major returns for our agency and our state.

# September
2001

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| 16<br>WMRC Founded 1984 | 17<br>National P2 Week Begins | 18 | 19 | 20 | 21 | 22 |
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## Spotlight on Alliance 2000 Achievements

During the past year, the GCP2A published the second edition of the 2000 Directory of Environmental Resources. The directory describes different government and not-for-profit environmental assistance programs available to businesses in the Greater Chicago area to better link them to existing environmental resources.

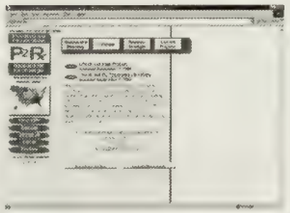
Many of the GCP2A members have been participating in the development of the GoalsChicago program, a local initiative to implement the Metal Finishing Sector Strategic Goals Program under the USEPA Common Sense Initiative. GoalsChicago guidelines, operating procedures, incentives and marketing materials have been developed. Approximately 14 Chicago area metal finishers have enrolled in the program and will soon undergo the evaluation process for award selection. Some of the GCP2A members have also participated in the development and implementation of a similar Strategic Goals Program for metal finishers in Addison, Illinois.

WMRC also administered the Fourth Annual Metropolitan Water Reclamation District (MWRDGC) Pollution Prevention Awards. This year, two companies received an award and three companies received certificates of commendation. As part of their pollution prevention efforts, the awards program has been written into the MWRDGCs draft National Pollutant and Discharge Elimination System permit from the USEPA.

# P2 Beyond Borders

## "Our projects are developing the structure for a comprehensive national network for pollution prevention information and expertise."

**--Jini Cook, P2Rx Coordinator**



While we utilize our resources to directly improve the economic and environmental condition of Illinois, WMRC believes that real problems don't stop at the state line, nor should our attempts to find their solutions. Our advanced efforts in information technologies have made WMRC a regional and national leader in developing tools for environmental applications. This leadership role has positioned WMRC as a major participant in two federally funded projects that provide decision-making resources to business and government across the nation. The Great Lakes Regional Pollution Prevention Roundtable (GLRPPR) and the Pollution Prevention Resource Exchange (P2Rx) have established partnerships that provide WMRC with the means to draw on the skills of hundreds of experts in dozens of fields, expanding the quality of services we can offer to Illinois. Combined, the two projects will bring approximately $570,000 federal dollars to WMRC's Illinois activities.

### Great Lakes Regional Pollution Prevention Roundtable (www.glrppr.uiuc.edu)

GLRPPR supports pollution prevention and beyond compliance activities through information sharing, issue discussion and program development among member organizations. This groundbreaking project pools the resources and expertise of eight Great Lakes states and two Canadian provinces. Debra Jacobson of WMRC is the current Executive Director of the Roundtable.

GLRPPR is in the process of redesigning the organizational web site and expanding the resources focused on issues relevant to the Great Lakes region, and through the P2Rx effort expanding the scope of resources available to GLRPPR members by linking with the other regional Centers.

In addition to the web site and two annual conferences, GLRPPR communicates and shares information with members through 17 e-mail listservs, a quarterly newsletter, and monthly conference calls with steering committee members. Membership in the Roundtable has grown to 173 members.

GLRPPR continues to be an active member organization of the Pollution Prevention Resource Exchange (P2Rx) program. In that role, the Executive Director of GLRPPR and the P2Rx Coordinator work closely to establish a common framework of goals and communication between the organizations.

### Pollution Prevention Resource Exchange (www.p2rx.org)

P2Rx was created in 1997 by the EPA to lay the groundwork for a seamless national network of easy accessible, high quality P2 information that promotes waste reduction throughout the U.S. P2Rx is composed of nine regional centers (including the GLRPPR) that offer a range of services, including information for industry and topic sectors, trainings, library resources, referrals and research. Through P2Rx, the centers collect, synthesize, and update technical information; and provide contact information for experts and other sources.

In January 2000, the Great Lakes Regional Pollution Prevention Roundtable (GLRPPR) and the Waste Management and Research Center (WMRC) were designated as the national coordinator of P2Rx for two years.

While numerous programs are underway, three of the major P2Rx projects include:

- A programs database to serve as a directory of people and programs with P2 expertise;
- A topic hub to organize and house P2 sector and topic information; and,
- An extension of outreach and services to other information providers.

# October
## 2001

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| 21 | 22 | 23 | 24 | 25<br>Governor's Pollution Prevention Awards | 26 | 27 |
| 28<br>Daylight Savings Ends | 29 | 30 | 31 | | | |
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## Regional Contact Information

Great Lakes Regional Pollution Prevention Roundtable


Debra Jacobson
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Pollution Prevention P2Rx Resource Exchange


Jini Cook
National Coordinator
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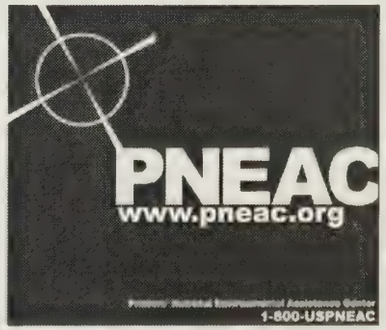
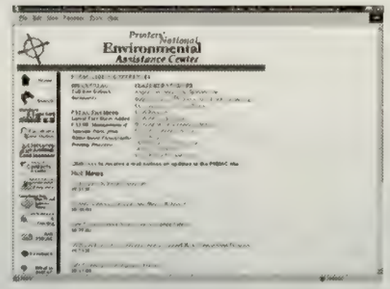
# PNEAC






## "Printing is a bigger national employer than the auto industry. It's time we pay some attention."

**Todd Schumacher, Printers' National Environmental Assistance Center**

WMRC is the prime contractor for the Printers' National Environmental Assistance Center (PNEAC), an enterprise dedicated to providing the most current and complete pollution prevention information and compliance assistance to the printing industry. Major partners include the Graphic Arts Technical Foundation and the University of Wisconsin. PNEAC serves printers, compliance assistance providers, technical assistance providers, small business development centers, regulatory agencies, and pollution prevention programs across North America and around the world. WMRC leads a partnership which includes industry experts from trade associations, government agencies, and university service providers located throughout the United States.

According to the Census Bureau, 2,400 printing companies in Illinois employ 60,000 workers and contribute over $4.6 billion to the Illinois economy each year. Since its inception, WMRC has invested over $1.2 million from USEPA for PNEAC to complete tasks such as training and education, writing and disseminating fact sheets and case studies, operating two printing industry e-mail discussion groups, and maintaining its popular website (www.pneac.org).

In the past year, WMRC staff and PNEAC partners have provided compliance and industry training to thousands of printers, technical assistance providers, and regulators in Illinois and several other states, including California, Florida, Nebraska, New Jersey, New York, and Pennsylvania. In addition to developing and conducting its own workshops, PNEAC staff have disseminated compliance and pollution prevention information by broadcasting an annual satellite videoconference and maintaining a presence as an annual co-sponsor of the National Environmental Health and Safety Conference, held each Spring.

The PNEAC website (www.pneac.org) offers original and adapted news listings of recent developments in environmental regulations, technology, publications, and other resources for printers and regulatory agencies; over 80 fact sheets and case studies, including examples of successes in waste reduction and pollution prevention. In addition, the site provides information on workshops, conferences, and courses on issues important to printers, as well as two e-mail discussion groups, which offer printers opportunities to discuss compliance and regulatory issues with industry experts. Via the website's "Ask PNEAC" feature, users may also post compliance and technical questions directly to printing industry experts. In the past year, PNEAC staff have provided answers to more than 360 requests via this service.

WMRC established PNEAC in 1995, under the Reinventing Government Initiative, to create a national compliance resource for the printing industry. Since then, USEPA has formed similar centers, including those serving the automobile, paints and coatings, chemical manufacturing, and metal finishing industries. PNEAC has grown to be one of the most successful of these centers, registering the most visits to its site of all the compliance assistance centers.

# November

## 2001

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## PNEAC National Videoconference

A perennial PNEAC success is its national satellite videoconference. In April 2000, PNEAC broadcast its fourth such videoconference, *High Performance Flexo: Printing with a Cleaner, Greener Image.* Nearly 1,000 attendees at 100 downlink sites in the United States and Canada viewed the program. In addition, countless viewers around the world who were unable to attend the videoconference broadcast tuned in to watch the program on the internet.

Printers, regulators, and educators across North America tuned in to PNEAC's panel of industry experts to absorb two hours of cutting edge information designed to assist in improving profitability and environmental performance.

The program provided practical advice about how printers can reduce costs while ensuring compliance with environmental regulations. The videoconference featured video case studies produced by PNEAC staff, presentations by the panel, and answers to live questions posed by viewers via phone, fax, and e-mail. The agenda included a video case study of Highland Supply Corporation in Highland, Illinois, and its innovations in developing a water-based ink system that has eliminated the use of solvent-based inks and clean-up solvents.

An archive of the webcast is available at www.pneac.org/videoconferences.

# Future Directions

**"The end game is to provide a high degree of utility for our clients. Increased state and federal funding is needed and will be pursued to support these efforts."**

**Gary Miller, Assistant Director, WMRC**

WMRC's services and programs work toward the overall objectives of **conserving natural resources**, improving environmental quality through **preventing pollution**, and increasing the strength of Illinois businesses through **developing better manufacturing processes**. During the past 15 years of operation of the Center thousands of companies have been helped with compliance issues and implementing pollution prevention technologies, tens of millions of dollars have been saved, and thousands of tons of wastes prevented. However, much remains to be done. Over the course of the next year we are reviewing and revising our strategic plan to ensure that WMRC effectively and efficiently fulfill its mission.

The overarching need for Illinois that we will be addressing is to develop and implement **more efficient resource management techniques**. This sustainable strategy will reduce depletion of our natural resources and preserve our most valued ecosystems. WMRC's focus is to address the various dimensions of industrial sustainability. Our primary strategy is to help whole industries **modernize through adoption of innovative pollution prevention technologies**. We will continue our efforts with metal finishers and in metal machining. In addition, we will strategically partner with organizations that have similar expertise in painting, fiberglass manufacturing, and environmental management systems. Our aim is to reach new and additional clients and client classes.

WMRC has initiated a project in partnership with the Southeast Chicago Development Commission to explore development of a pilot network of companies to optimize the use of raw materials and wastes on a local basis. Lessons learned from this project will be used to expand this effort in other communities. We will also be expanding our capabilities to help companies assess the **life-cycle impacts of their processes and products, to evaluate alternative "green" chemistries and designs, and to implement preferred technologies**.

Each year natural resources in Illinois continue to be contaminated through the release of hazardous wastes and toxic materials spills. Ecosystem damages from these releases are not fully restored. As a result, in a number of instances the functioning of our ecological systems that support our quality of life is impaired. This trend needs to be reversed by working with those responsible to implement ecosystem restoration. WMRC will continue to actively work on such restoration through continued development of the Natural Resource Trustee Program. WMRC will work to develop better methods to determine ecosystem impairment and **restore damaged habitats**. This includes implementation of innovative dredging technologies for the restoration of portions of the Illinois River, to develop appropriate habitat within the river system, and to find beneficial uses for recovered sediment.

Over the next year WMRC will work with other parts of DNR and other state agencies to implement more **environmentally sound practices to have state government take a leadership position within the state and to reduce the environmental footprint of state government.** This includes purchasing supplies with high recycled content, cleaners that have minimal environmental insult, appliances which have high energy efficiency, vehicles with high environmental ratings, and so forth. WMRC will also work with communities on a grant program to implement environmentally sound community practices and programs under the **Green Illinois Initiative**. WMRC has joined USEPA's WasteWi$e program and **adopted a policy** to practice pollution prevention and recycling in all our operations. We will look for ways to further reduce wastes from our offices and laboratories including greater use of communication technologies to minimize the risks and costs of travel.

Some of the greatest impacts on our environmental quality come from the use of energy and water. In the energy area, our focus will

# December

## 2001

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| 23 | 24 | 25 Christmas Day | 26 | 27 | 28 | 29 |
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be on utilizing **clean, renewable energy** sources and technologies such as fuel cells and to evaluate the life-cycle environmental performance of energy technologies for use in residences and manufacturing. Several WMRC projects have proven that as much as **95% of water can be saved,** economically, in certain manufacturing process. Our experience has shown that in process after process much can still be done to reduce water use, conserve raw materials, reduce waste generation and save energy in manufacturing facilities.

Finally, more effort will be devoted to **make the public aware** of waste-related environmental issues and effective solutions. This will include greater use of the Internet, distribution of data to the public, enhancing the annual Governor's Pollution Prevention Award program, documenting our results, producing video tapes to highlight successful technologies, and workforce training both on-line and via workshops. While WMRC will work to increase use and data availability, we will also seek to develop means for obtaining more intelligent **information** for our clients. The end game is to provide a high degree of utility for our clients. Increased state and federal funding is needed and will be pursued to support these efforts.

State of Illinois Home -- www.state.il.us

Illinois Department of Natural Resources -- http://dnr.state.il.us/

## WMRC Sister Organizations

Illinois Natural History Survey -- www.inhs.uiuc.edu

Illinois State Geological Survey -- www.isgs.uiuc.edu

Illinois State Museum -- www.museum.state.il.us/

Illinois State Water Survey-- www.sws.uiuc.edu/

## WMRC Partners and Projects

DOD/IL P2 Partnership -- www.wmrc.uiuc.edu/partners

Great Lakes Regional Pollution Prevention Roundtable -- www.glrppr.uiuc.edu

Illinois Great Printers Project -- www.pneac.org/greatprinters/gppmoreinfo.html

Illinois Green Chemistry -- www.wmrc.uiuc.edu/gchemistry

Illinois Industrial Cleaning -- www.wmrc.uiuc.edu/cleaning

Printers' National Environmental Assistance Center -- www.pneac.org

Pollution Prevention Resource Exchange -- www.p2rx.org

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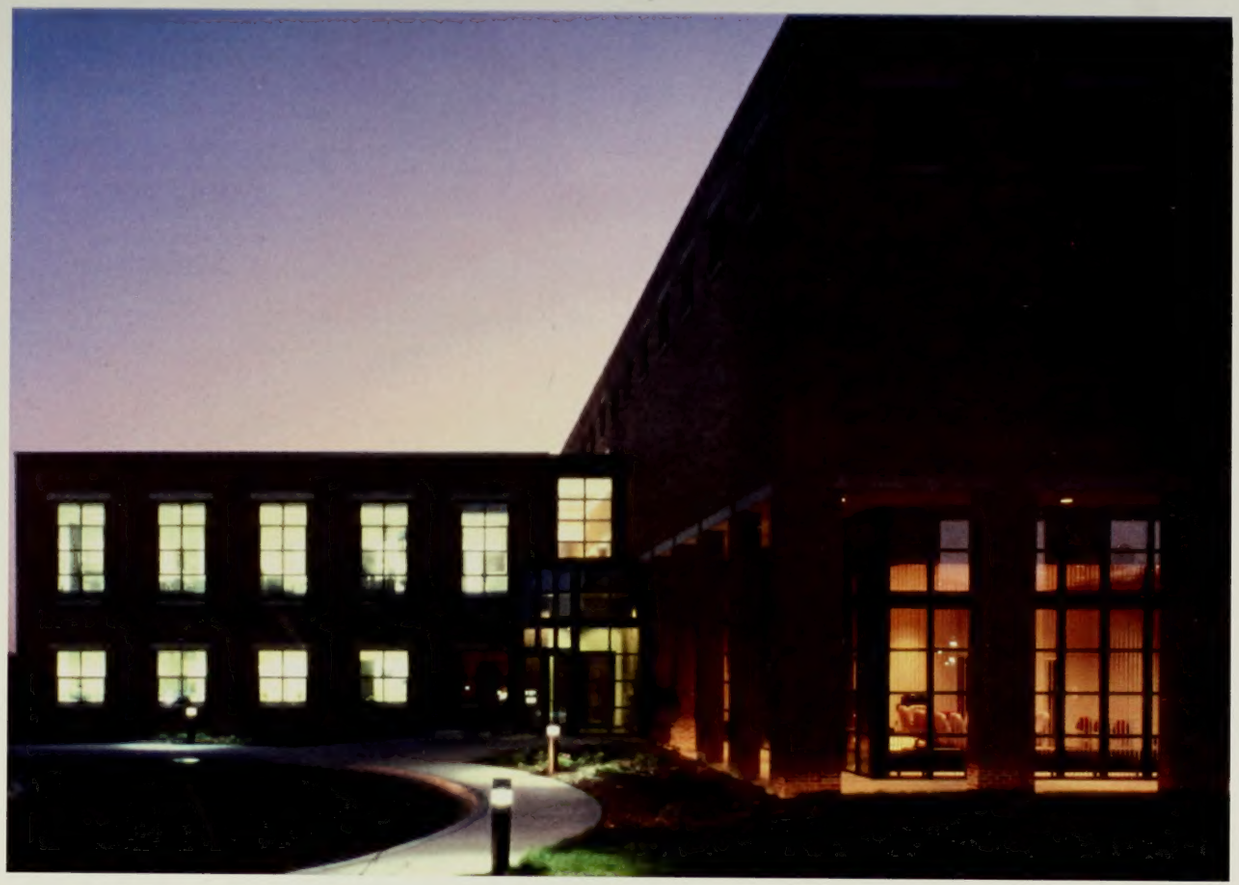

**www.wmrc.uiuc.edu**

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